Energy in northeast Asia

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Regional dimensions of ecological problems are emerging rapidly in northeast Asia, where environmental degradation is closely associated with rapid economic growth. Further economic growth, however, is itself threatened by ecological limits or by mounting public concern over environmental harm. Environmental deterioration and the emergence of new resource scarcities could generate new subnational and regional conflicts in the region.

Conversely, the recognition of a shared regional and global environment—and the economic and political incentives to cooperate stemming from cross-border ecological degradation—could generate a new stimulus for regional environmental cooperation.

In approaching these issues, we draw on the central insights of three theoretical approaches, which are described below.

<u>Environmental security.</u> The term "environmental security" emerged in the 1980s in the search for an alternative to Cold War discourse. Often linked with the terms "comprehensive" and "cooperative" security, environmental cooperation was held to be a way to build confidence, while environmental degradation was portrayed as a source of interstate conflict. Environmental security was to be realized primarily within the spatial level at which environmental problems exist, that is, at the "eco-regional" level. An early round of studies aimed primarily to determine if multilateral environmental cooperation could increase trust and avoid disputes between states over resource-related issues (the "Westing school"). Some analysts concluded that environmental degradation already threatened security.

In the early 1990s, rebuttals began to appear. Security analysts argued that the concept of security entails threat capabilities and control of sovereign territory, whereas environmental issues are trans-boundary and not amenable to orthodox security solutions (that is, the exercise of military power). Others attempted to create a middle ground by confronting the multicausal, multidimensional, and nonlinear complexity that characterizes linkages between security, economic, and environmental spheres (the "Homer–Dixon school"). All these studies tend to concentrate on the potential for inter- and intrastate conflict rather than cooperation.

<u>Environmental regimes.</u> Prompted by the 1992 Earth Summit, a slew of studies on environmental cooperation emerged concurrently with the notion of "environmental security." Many drew on the institutionalist tradition of regime theory with its emphasis on rights, roles, and the centrality of consensual knowledge in substituting for the coercive power of a hegemonic state under conditions of international anarchy (the "Harvard school").

Such studies tested the hypothesis that international environmental institutions perform three functions: (1) increase governmental concern; (2) enhance the contractual environment; and (3) increase national capacity, thereby improving national environmental performance. (Here, institutions referred not only to organizations, but also to sets of rules often codified in conventions and protocols between states.)

It is also clear that states employ two different methods to cooperate on international environmental problems. The first—interstate collaboration—involves cases where vital national interests are determined to be in actual or potential conflict and typically entail a distribution of costs and commitments. In contrast, interstate coordination involves cases where all states have an interest in the benefits of cooperation. Collaboration is more difficult to achieve.

Another approach focused on the emergence of “epistemic communities” to analyze the emergence of regional and global environmental regimes. In this analysis, scientists and the dissemination of scientific knowledge to policymakers were crucial in building support for regional cooperation. Environmental interests—as articulated by scientists and their supporters—became a driving force in interstate relations, transcending strategic and economic interests.

<u>Environmental governance.</u> A third theoretical tradition draws from a political economy perspective to analyze the underlying economic interests and incentives of different actors in developing governance frameworks—systems of rules and enforcement strategies—to govern common-property resources. In this framework, individual users of an ungoverned common resource are subject to a “prisoner’s dilemma” paradox: the maximization of individual utility undermines collective utility by depleting the resource. What is rational at the individual level adds up to a social irrationality (the Resources for the Future-International Institute for Applied Systems Analysis [RFF-IIASA] school).

The domain of regional environmental governance arguably includes cross-border ecosystems, such as atmosphere and oceans. At Nautilus, we have also developed the concept that, in the context of economic integration, domestic resources take on common property characteristics. Competitive markets for trade and investment create “prisoner’s dilemma” style paradoxes for the governance of within-border resources. Economic interests in resource sustainability require cooperation to establish common regulatory frameworks not only for cross-border but for trade-exposed resources.

<u>Early applications.</u> In the broadest terms, the geopolitics-based realist approach suggests that environmental cooperation is strictly subordinated to “high” military and security interests. Japanese reluctance, U.S. neglect, Russian introspection, and Chinese defensiveness combine to minimize commitment and implementation. Only one small power—South Korea—has attempted to exploit the remaining space to promote multilateral environmental cooperation. But South Korea lacks the capability to kick-start a cooperative or even merely collaborative effort. Meanwhile, North Korea keeps military security issues in the forefront and participates in an irregular, half-hearted fashion. In short, geopolitics dominates geoecology.

The institutionalist school would retort that these dialogues are tentative first steps toward the construction of inclusive, cooperative regimes. Environmental threats such as acid rain will increase dramatically in intensity and impact. Environmental interdependencies will be more widely recognized as scientists provide currently lacking data and analysis to inform public opinion and policymakers. Moreover, over time, a core of institutions will create a cadre of bureaucrats and others committed to institutional expansion.

International organizations such as the United Nations Development Program (UNDP) arguably have and likely will make a difference, nurturing regional environmental networks that have continued to meet and exchange information even at the height of military confrontations in recent years. Already, normative shifts are evident in the environmental principles agreed to in the Tumen River project and other nascent regional regimes. Moreover, regional contact among domestic nongovernmental organizations is burgeoning on environmental issues, hastened by the Internet. In short, the jury is still out on whether regional regimes and institutions can overcome entrenched security-dominated and hostile political and military elites. Given the history, the progress to date is remarkable and worthy of attention.

Finally, the political economy school suggests that increased economic integration in northeast Asia provides incentives—and imperatives—for enhanced environmental cooperation. With integration, differing domestic environmental policies become nontariff barriers to trade, reducing economic growth and raising the prospects for trade conflict. Standards that are harmonized across borders, on the other hand, facilitate trade.

Moreover, resource depletion and ecosystem degradation reduce resource productivity and increase production costs, hindering economic growth. Pollution of the Tumen River, for example, is so severe that cleanup efforts must precede regional development: the need for water clean enough for industrial and agricultural use will propel cleanup and watershed management, an effort that requires cooperation among Russia, North Korea, northeast China, and Mongolia. Other cross-border, common-property resources such as the oceans and atmosphere likewise require collective action for sustainable utilization. The economic losses implied in the collapse of regional fisheries or the explosion of acid rain provide powerful incentives to cooperate in establishing common management frameworks.

Economic interdependence, ecological interdependence and the trans-boundary intergovernmental cooperation they propel will also generate a slow but irreversible shift in perceived identity. With the recognition of shared ecological resources and cross-border cooperation, a new sense will emerge of the region and perhaps of the world as a whole.

Armed with these three theoretical approaches, we have concentrated on the nexus of energy-related environmental and security problems in the northeast Asian subregion—perhaps better described as an “anti-region” given the long history of imperial domination, colonial occupation, cultural antagonism, and security confrontations that divide the region against itself.

Environmental and other security-related dilemmas

In this section, we will describe the nexus of issues between energy, environment, and security and review the current situation (in some depth) with regard to: (a) national and regional energy demand projections, (b) trans-boundary acid rain and regional oceanic environmental impacts from maritime oil transport and rapid coastal urban–industrial development, (c) regional dimensions of global climate change, and (d) financing the transition to environmentally sustainable energy development in the northeast Asian region.

Energy demand projections. The requirements for energy services to fuel development in northeast Asia has been growing rapidly in the last two decades. This has translated into a rapid increase in the rate of fossil fuel use, a trend that is expected to continue over the next two decades. Northeast Asia's shares of both global fossil fuel use and world carbon dioxide emissions are expected to continue to rise; nearly a third of the growth in annual carbon dioxide emissions through 2010 is projected to come from the region (discussed later in this chapter in Regional Dimensions of Global Climate Change). This growth in fuel use has the potential to exacerbate global problems with regional consequences, including climate change and marine pollution. Switching to alternative low-carbon and no-carbon energy sources and energy efficiency measures shows the best potential to reduce carbon dioxide emissions at low (sometimes negative) costs, and also help reduce emissions of acid gases. Options for regional cooperation to help to reduce global impacts of energy use in the region are discussed. Of particular importance are the generation of acid rain precursors that will arise from these current and projected patterns of energy use (dealt with in the next section).

Table 18-1 presents the current pattern of commercial fuel use in the countries of northeast Asia by type of fuel (British Petroleum 1996; United Nations 1994; Von Hippel and Hayes 1995). The countries of northeast Asia consumed slightly under 20% of the world's supply of commercial fuels in 1995, including about 17.5% of the petroleum products, 4.5% of the natural gas, and more than a third—almost 37%—of the world's coal. The sectoral breakdown of fuels demand in several of the countries of the region (as of 1992) is shown in Figure 18-1 (Sinton 1996; KEEI 1996; MITI 1995; Von Hippel and Hayes 1995). Here the industrial sector fraction of fuels demand is greater in the less developed countries—China and North Korea—than in Japan and South Korea. Conversely, energy demand in the transportation sector makes up a significantly smaller portion of total energy use in China and North Korea. Both North Korea and China consumed approximately 1.2 metric tons (t) of oil equivalent (toe) of end-use fuels per capita in 1990 and 1992 (respectively), while South Korea used 2.2 toe per capita, and Japan used 2.6 toe per capita (UN–ESCAP 1995)

The major point here is that energy use in Asia—particularly in China and North Korea—would seem to have substantial "room to grow" before it reaches the levels currently maintained by Japan and other developed nations. The consumption of transport services, which Chinese and North Koreans currently use very lightly, is one of the key areas that is bound to grow, with—in all probability—a significant increase in transport energy use.

Table 18-1. Fuels consumption in northeast Asia and the world.

	Energy Use in Northeast Asia and the World, 1995[a] Unit: Million tonnes of Oil Equivalent							
Country	Oil	Natural Gas	Coal	Nuclear Energy	Hydro-electric	Total	Fraction of NE Asia	Fraction of World
China	157.5	15.8	640.3	3.3	16.2	833.1	52.4%	10.2%
Chinese Taipei	35.4	3.9	17.0	9.1	0.8	66.1	4.2%	0.8%
Hong Kong[b]	4.2	-	5.5	-	-	9.7	0.6%	0.1%
Japan	267.3	55.0	85.9	74.3	7.7	490.2	30.9%	6.0%
Mongolia[b]	0.6	-	1.9	-	-	2.5	0.2%	0.0%
North Korea[c]	3.5	-	32.4		5.7	38.1	2.4%	0.5%
South Korea	94.8	9.2	27.3	17.3	0.5	149.0	9.4%	1.8%
Total Northeast Asia	563.3	83.9	810.3	104.0	30.9	1,588.8	100.0%	19.5%
NE Asia Fraction of World	17.5%	4.5%	36.7%	17.4%	14.2%	19.5%		
Total Rest of World	2,663.6	1,799.7	1,400.4	492.4	187.6	6,547.0		80.5%
Total World	3,226.9	1,883.6	2,210.7	596.4	218.5	8,135.8		100.0%

a Figures in this table are for 1995 (BP World Energy Statistics) for all countries except Hong Kong and Mongolia (1992 figures from UN) and North Korea (1990 figures from Von Hippel and Hayes, 1995).

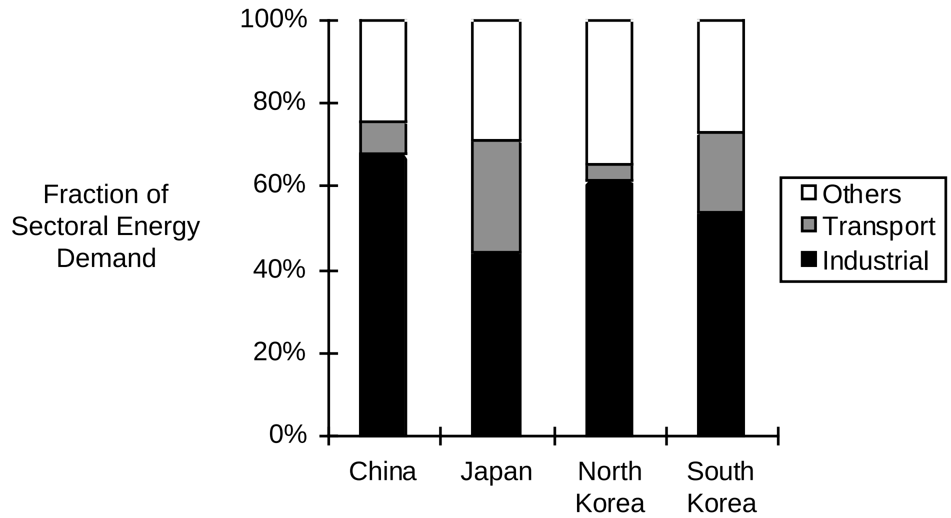
b 1995 fuels use in Hong Kong and Mongolia was probably somewhat higher than the 1992 values shown.

c Energy consumption in North Korea was probably less than the 1990 estimate in the table.

Scenarios of Future Energy Use in the Region. As projected by several research groups[1], Table 18-2 provides an overview of the results of country-level scenarios of the average annual growth rate of primary commercial energy use from the early 1990s to 2010 (scenario base years vary among research groups). In each case the "Base", "Business as Usual", or "Reference" scenario prepared by each group is reported.

Although the results of these scenarios vary somewhat, the overall pattern of strong growth in primary fuels use—in the range of 4–5% per year for all countries except Japan—is uniform. At this growth rate, energy use in the countries of the region (with the exception of Japan) will rise by about 120% of today's level by just the year 2010. As most of this fuel will continue to be fossil-derived, the increase in greenhouse gas emissions from the countries are significant enough to merit extreme global concern, in addition to the ramifications for acid rain.

Another key aspect of the projected growth in fuels use in northeast Asia is the shift in the patterns of fuel use, imports, and exports in the region. Of particular concern is the projected shift of China over the next two decades from being a small net exporter of oil in 1992 to being a very large net importer, with oil import needs second only to Japan in the region, and significantly greater overall oil demand. This shift, as empha-



Source data for graph
Units: million tonnes oil equivalent

	Industrial	Transport	Others
China	948.3	113.1	340.1
Japan	141.8	85.9	91.7
North Korea	16.8	1.0	9.4
South Korea	50.8	18.5	25.3

Figure 18-1. Commercial fuels consumption in four countries of northeast Asia (1992).

sized by Fujime (1996) and Fesharaki et al (1995) in their respective scenarios, will (together with flat production and growth in domestic consumption in the Asian countries now exporting oil—especially Indonesia) shift the focus of regional imports to the Middle East, increase competition for crude, and increase the pressure on oil transport infrastructure, including sea lanes used by tankers.

Critical energy-environmental issues for regional environmental governance

Energy-related environmental issues are not the only important trans-boundary environmental issues in the region. Other important concerns are migratory species, biodiversity, especially cross-border biodiversity management: toxic waste disposal, etc. However, energy-related environmental issues are arguably of critical importance to achieving political–military, energy, and environmental security, and are therefore central issues to be addressed in any system of regional environmental governance. The key energy-related environmental issues are:

<u>Acid rain and alternatives to coal.</u> Undoubtedly, the most urgent issue is the widespread and growing problem of trans-boundary, energy-related air pollution—

Table 18-2. Projections of primary[a] commercial[b] fuel use in northeast Asia: annual average growth rates from the early 1990's through 2010.

	Country				
Source of Projection[c]	China	Ch. Taipei/ Hong Kong[d]	DPRK[e]	Japan	ROK[f]
CCICED[g]	3.88%				
East-West Center[h]	3.63%				
Institute of Energy Economics, Japan[i]	4.64%	3.96%		1.22%	4.68%
Korea Energy Economics Institute[j]					5.91%
RAINS-Asia[k]	4.54%	4.18%	5.33%	1.83%	4.98%
US DOE EIA International Energy Outlook[l]	4.49%			1.91%	
World Bank[m]	4.50%				

a Primary energy use includes fuel used in conversion and transformation processes such as coal cleaning, electricity generation, and oil refining.

b Excludes those fuels that are typically not (at present) formally traded in international markets, such as biomass for domestic cooking.

c In many, but not all cases, more than one scenario was prepared by the sources cited.

d Chinese Taipei and Hong Kong combined.

e Democratic People's Republic of Korea (North Korea)

f Republic of Korea (South Korea)

g Working Group on Energy Strategies and Technologies of The China Council for International Cooperation on Environment and Development (CCICED), Alternative Energy Strategy Scenarios for China. Prepared by the Institute for Techno-Economics and Energy Systems Analysis (ITEESA), Tsinghua University, Beijing, and China Integrated Resource Planning Promotion Network (IRPPN) International Energy Initiative (IEI). Beijing, China. April, 1996.

h Fesharaki, F., A. L. Clark, and D. Intarapravich, editors, Pacific Energy Outlook: Strategies and Policy Imperatives to 2010. East-West Center Program on Resources: Energy and Minerals. East-West Center, Honolulu, Hawaii, U.S.A. March, 1995.

i Fujime, K., "Long-Term Energy Supply/Demand Outlook for Asia APEC Nations". Energy in Japan, January, 1996. The Institute of Energy Economics, Japan (IEEJ), Bimonthly Report No. 137. 1996.

j Korea Energy Economics Institute (KEEI), [Energy Scenarios to 2030—Document in Korean]. KEEI, Seoul, Korea. November, 1994.

k RAINS-Asia Software

l U.S. Department of Energy, Energy Information Administration (US DOE EIA), International Energy Outlook, 1996. U.S. Department of Energy, Washington, D.C., U.S.A. 1996.

m The World Bank, China: Issues and Options in Greenhouse Gas Control, Summary Report. The World Bank, Industry and Energy Division, Washington, D.C., U.S.A. December, 1994. Page 39.

primarily acid rain generated by coal burning in northeast Asia.[2] Important dimensions of this issue are: (i) the sources of acid rain; (ii) the environmental, economic, and social problems associated with expanding use of coal; and (iii) the feasibility, economic and environmental costs, and security impacts of alternatives to "dirty coal," including sulfur-reducing coal technologies, nuclear power, natural gas, solar and wind power, and energy efficiency.

Northeast Asia faces a dilemma in its choice of energy strategies. In the coming decade, rapid economic growth will drive a huge increase in energy demand. Although demand will be greatest in China, Japan and South Korea will also increase energy capacity, and North Korea and the Russian Far East hope to attract foreign investment to do the same. The dilemma is that the primary projected strategies to meet the demand—expansion of (dirty) coal, maritime oil transport, and nuclear power—are problematic, both on environmental and security grounds.

An increased reliance on coal bodes two major negative ecological impacts: a dramatic increase in acid rain-causing sulfur emissions (see Table 18-3); and a large increase in carbon dioxide and other greenhouse gas emissions. At current projections, China will emerge as the world's leading source of carbon emissions within 25 years.

Acid rain is a problem of both domestic and cross-border proportions, with dirty coal-burning power plants in northeastern and southeastern China as the primary source. Acid rain is already at relatively high levels in much of China, the two Koreas, and Japan (and would be higher still if it were not for the buffering effect of the dust-laden winds from the interior of the continent). Levels projected by the Regional Air Pollution Information and Simulation Network–Asia (RAINS–ASIA) for 2020 will reach unprecedented levels in parts of China—much higher than was recorded at the worst sites in Eastern Europe. These estimates take into account only sulfur-related acid rain, not nitrous oxides nor ammonia, which are also increasing rapidly in the region. In short, much of the region seems to be approaching or exceeding critical levels beyond which ecosystem damage occurs, and critical loads at which severe public health damages become apparent. A particularly important impact may be the lowering of agricultural and crop productivity, especially in China, which already faces reduced food

Table 18-3. Emissions in northeast Asia by country under BAU[a] scenario (million tonnes per year).

Country	S02			NOx		
	1990	2010	2020	1990	2010	2020
Northeast China	11.9	25.3	32.5	6.9	N.A.	26.8
Japan	0.8	1.0	1.1	2.6	N.A.	4.6
South Korea	1.7	4.1	5.6	1.1	N.A.	5.1
North Korea	0.3	0.9	1.3	0.5	N.A.	2.4
Total	14.7	31.3	40.5	11.1	N.A.	38.9

[a] "business as usual" scenario

N.A. = Values not calculated by van Aardenne (1996).

Source: D. Streets, Energy and Acid Rain Projections for Northeast Asia, paper to ESENA2 Workshop, Alameda, November 1996, forthcoming ESENA working paper from Nautilus Institute.

security due to land use conversion and many other problems that afflict its ability to produce food.

The regional distribution of these acid rain precursors is an important political issue laden with conflict potential. According to recent and comprehensive estimates (refer to Table 18-4), some 37% of Japan's acid rain problem is sourced from China. In North Korea, 34% is sourced from China and another 30% from South Korea. The region's oceans are especially vulnerable: 15% of China's sulfur emissions are deposited in the ocean, while for South Korea and Japan the figures are 51% and 48% respectively. On both land and sea, acid rain undermines biological productivity with implications for major crop and fish food sources, and threatens to degrade the region's forests.

Worries over widespread, regional environmental damage have prompted some policy analysts, including in Japan and Korea, to promote nuclear power as an alternative to coal-fired power. However, there are also large environmental externalities associated with nuclear power, including the risk of Chernobyl-style accidents, the production of radioactive waste, equipment and buildings, and routine radioactive emissions.

Currently, nuclear power accounts for between 25–50% of electricity generating capacity in Japan, Taiwan, and South Korea. This fraction is projected to increase to 35–55% by 2010. Japan is committed to breeder reactors as is South Korea's nuclear establishment, along with mixed-oxide fuel plutonium recycling (although South Korea has forsworn plutonium reprocessing).

The construction of nuclear power plants continues to pose risks, due to siting and seismicity problems (in Japan), shoddy and corrupt construction (South Korea), lack of operating and maintenance funds (Russian Far East), and lack of safety, regulatory, and trained operating staff (North Korea). Emergency evacuation poses intractable, likely impossible problems in all the densely populated states of the region. None of the states has adopted a nuclear waste disposal strategy. Public accountability for nuclear power decisions is low or nonexistent in the region. Proliferation issues are a concern in some cases (North Korea).

Another option is to switch to natural gas, either imported by sea, or, more hypothetically, by massive pipeline construction from Siberia through China to North and South Korea, and on to Japan. These two strategies both entail very large capital investments in the supply and transport side, as well as in retrofitting cities to distribute natural gas. As a relatively clean fuel, however, natural gas has some strong advantages over coal, oil, and nuclear power, assuming losses of methane in transmission systems can be reduced.

The large environmental and security externalities associated with dirty coal and nuclear power make both unattractive. There is a third alternative, however, based on a combination of clean coal, fuel switching, and energy efficiency. The "Third Path" strategy is focused on minimizing waste, on both the demand and supply sides of the energy equation. It requires investment in widespread improvement in the efficiency of end-use in all sectors, as well as expansion of coal-based electricity supply which controls sulfur emissions.

Studies at Lawrence Berkeley Laboratory, for example, have shown that China's energy services have grown more (since the early 1980s) from its increased end-use efficiency than from investment in new energy supplies. Substantial and relatively

Table 18-4. Transboundry Transport of Acid Rain in Northeast Asia. Regional source-receptor relationships for Eastern Asia. Shown in the percentage of each receptor's deposition from the responsible source region. Columns represent sources and rows receptor regions. The last column presents the total deposition on each region

Shown is the percentage of each receptor's deposition from the responsible source region. Columns represent sources and rows receptor regions. The last column presents the total deposition on each region in kilo-tonnes S/yr and the last row presents each country's emissions in kilo-tonnes SO_2/yr.

	China												Japan							South Korea				
Receptor / Source	NE Plain	Shenyang	Hebei-Henan-Anhue	Beijing	Tianjin	Shandong	Shanxi	Taiyuan	Inner Mongolia	Jiangsu	Shanghai	Zhejiang	Chugoku-Shikoku	Chubu	Hokkaido-Tohoku	Kanto	Kinki	Kyushu-Okinawa	North Korea	North	Seoul-Inchon	South	Pusan	Total Deposition
Oceans	14	1	11	1	1	8	1		2	14	8	6	2	2	2	1	2	2	3	3	4	4	8	1257
China																								
NE Plain	74	4	8	1	1	2	1		5	1									3					620
Shenyang	66	17	7	1	1	3	1		2	1									1		1			13
Hebei-Henan-Anhui	1		61	5	4	5	6	3	3	11	1	1												707
Beijing			41	32	7	4	7	2	5	1														17
Tianjin	1		38	24	26	5	3	1	2	1														31
Shandong	2		18	1	1	35	2	1	1	40	1													359
Shanxi			29			2	48	15	4	2														119
Taiyuan			15			2	44	35	2	1														10
Inner Mongolia	28	1	14	2	1	1	9	1	45															209
Jiangsu			19			4				62	8	6												346
Shanghai			3			1				24	53	18												37
Zhejiang			7			2				19	11	61												111
Japan																								
Chugoku-Shikoku	10	1	6	1	1	2	1		1	3	1		35	13	6	1	1		3	3	4	2	4	36
Chubu	1		1							1				73	13	3	1				1	1	1	29
Hokkaido-Tohoku	3		3			1				2				14	39	20	5	1	1	1	2	2	4	57
Kanto	2		3			1	1			2	1	1		2	6	50	19	1	1	1	2	2	4	21
Kinki	2		3			2	1			3	1	1		2	2	7	42	13	1	1	2	4	11	49
Kyushu-Okinawa	4		7	1	1	5	1		1	8	2	2		3		1	4	29		1	2	5	21	23
North Korea	17	1	6	1	1	3	1		1	3									29	6	30		1	170
South Korea																								
North	3		4			2				4	1								3	30	37	8	5	67

Source: G. R. Carmichael and R. Arndt, Deposition of Acidying Species in Northwest Asia, paper to ESENA2 Workshop, Alameda, November 1996, forthcoming ESENA working paper from Nautilus Institute.

cheap, fast, and incremental (therefore, low risk) efficiency options also exist for North Korea. Similar potential exists in South Korea and to a lesser extent in the most advanced and technologically innovative economy in this region, Japan.

The "political economy" of the "Third Path" revolves around the prospective cost to Japan of unrestrained growth in coal use in China (and to a lesser extent, in the two Koreas) on the one hand; and the cost to China of reducing its sulfur emissions on the other. Technological controls include: (1) desulfurization of fuel oil, coal, and diesel fuel before combustion; (2) desulfurization of fuels during combustion by additive processes and flautist bed combustion; and (3) capture of sulfur after combustion by flue gas treatments such as wet limestone scrubbers.

Relatedly, these and end-use efficiency measures overlap with those required to reduce China's prospective energy-related greenhouse emissions to acceptable levels. Thus, the Organization for Economic Cooperation and Development (OECD) countries as a whole, and Japan and South Korea in particular, have a strong common interest in financing the requisite technological advances in China's energy sector.

<u>Energy-related marine degradation.</u> Energy-related marine degradation in the Sea of Japan and the Yellow Sea are a second critical issue for regional environmental security. Such degradation stems primarily from the transport, storage, and runoff of oil, and the ocean dumping of ship ballast and nuclear waste. Both oil and nuclear pollution have already ignited interstate hostilities.

The potential impact of increased fossil fuel consumption in northeast Asia on the marine environment are manifold. Increased use of fuels in northeast Asia and Asia generally is likely to affect the global marine environment. As noted above, oil imports by China alone are projected to reach 132 million metric tons(t) of oil equivalent (toe) per year by 2010, and net imports to the Asian APEC region as a whole are expected to rise from about 75 million toe in 1992 to 432 million toe in 2010, an increase of nearly 500%. What this means is that much more oil will be on the high seas, traveling to Asian countries from exporting nations that are increasingly in the Middle East. Fesharaki et al (1995) estimate that 95% of crude oil imports to Asia and the Pacific will come from the Middle East by 2010, as compared with 70% in 1993. This vast potential increase in tanker traffic brings with it significant possibilities for increased marine oil pollution from both routine and accidental spills.

The most visible and prevalent example of direct spillage of energy products into oceans is that of "oil spills." Crude oil and refined products spill during routine operation of offshore oil rigs, from oil tanker filling and off-loading operations, during the cleaning of tankers, as spillage from other (non-tanker) ships that use petroleum fuels, and as a result of leakage from undersea pipelines, as well as during less frequent but better-publicized oil tanker accidents and "blowouts"[3] at offshore oil platforms. Table 18-5 provides estimates of the current sources and magnitude of marine oil pollution. Of the sources listed, marine transportation, including oil tanker traffic, is estimated to be the largest single source.

Oil spills are toxic to many forms of marine life, as well as fouling beaches and affecting other ecosystems and man-made installations along the shoreline. Oil floating on the ocean's surface can coat marine birds, making them unable to fly, reducing the insulating properties of their feathers (so that they can no longer stay warm), and usu-

Table 18-5. Sources of petroleum hydrocarbons in the marine environment (millions of tonnes annually).[12]

Source	Probable Range	Best Estimate
Natural	0.025 - 2.5	0.25
Atmospheric Pollution	0.05 - 0.5	0.3
Marine Transportation	1.00 - 2.60	1.45
Offshore Petroleum Production	0.04 - 0.06	0.05
Municipal and Industrial Wastes and Runoff	0.585 - 3.21	1.18
Total	1.7 - 8.8	3.2

From Lazarus, M., and D. Von Hippel, A Guide to Environmental Analysis for Energy Planners. Stockholm Environment Institute-Boston (SEI-B) Report, SEI-B, Boston, MA, USA. 1995.

Original Source: M.H. Katsouros, Chapter 5 in Hollander, J.M., Editor, The Energy-Environment Connection. Island Press. Washington. D.C., USA. 1992.

ally eventually killing them. Oil spills disrupt the food chain by killing phytoplankton and zooplankton[4] at or near the oceans surface. This is important throughout the world, but nowhere more than in Asia, with its high population densities and where so many people (A) live in coastal areas, and (B) depend on marine products for food and livelihood. Food chain disruptions that reduce yields (or usable yields) of fish and shellfish put an additional burden on a regional food production system that is already operating with little capacity to spare.

Heavier oil products, and the heavier fraction of crude oils, sink to the bottom, where they can coat shellfish beds, making shellfish and other invertebrates inedible. Damage from oil spills may persist for many years, as compounds contained in oils can remain both in the bodies of organisms and in marine sediments. Oil spills can be spread rapidly by tides, currents, and winds, making them a long-term threat to the regional and global marine environment, in addition to their acute local impacts.

The risk of oil spills in the Asian region in general, and in northeast Asia in particular is likely to increase as more and more tankers carrying oil from the Middle East and elsewhere to China and other nations add to congestion in the relatively few major sea lanes in the region (Valencia 1995).[5] These sea lanes are already crowded by tanker and freighter traffic serving the booming economies of the area.

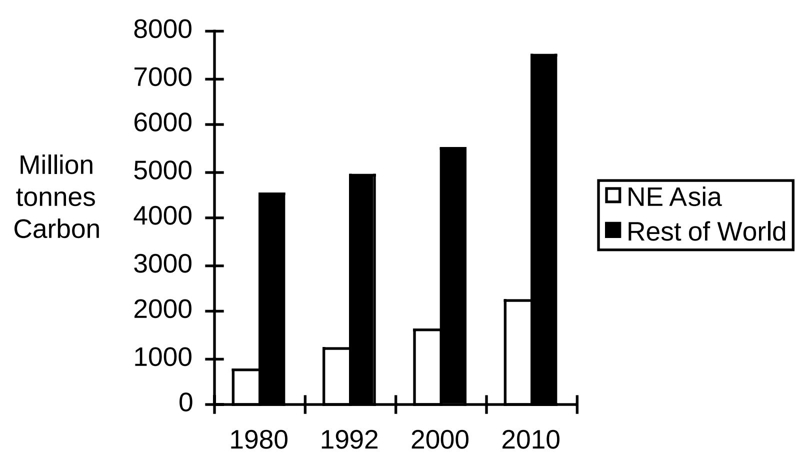
The Northwest Pacific Action Plan already has identified imperatives for regional cooperation to manage sea lanes and traffic, respond to catastrophic oil spills, monitor marine oil pollution and nuclear waste dumping, and promote cross-border integrated coastal management strategies to reduce runoff.

The role to be played by navies in monitoring and verifying such agreements, enforcing agreements concerning the use of sea lanes and hazardous straits, and responding to catastrophic spills, is an important subject for further investigation. Such cooperation might spill over into high geopolitics by providing opportunities for inclusive confidence building between otherwise adversarial states.

Regional dimensions of global climate change

The current and projected growth in energy use in northeast Asia, particularly in a "business-as-usual" world, means that the region will play an extremely important role in either exacerbating or reducing the impacts of global climate change. Scientific consensus is that increasing concentrations of greenhouse gases in the atmosphere, prominently including carbon dioxide and methane emitted by fossil fuels combustion, will cause global climate to change in the next several decades, if such changes have not already occurred (IPCC 1996). The impacts of climate change will vary widely across the globe, but those countries with the largest, least affluent populations per unit land area will likely be among the most vulnerable. China and North Korea, therefore, face somewhat of a dilemma. Development is necessary in both human and political terms, but one of the impacts of development is likely to be increased greenhouse gas emissions, which puts those countries (and the globe) at risk from the impacts of climate change.

Projected greenhouse gas emissions. Figure 18-2 shows a comparison of one set of greenhouse gas emissions projections for northeast Asia as compared with projections for the rest of the world. In 1980, the countries of northeast Asia accounted for just under 15% of the world's total carbon emissions. By 1992, the fraction had grown to



Source data for figure
Units: million tonnes carbon

	NE Asia	Rest of World
1980	761	4,491
1992	1,197	4,896
2000	1,604	5,465
2010	2,246	7,502

Figure 18-2. Historical and projected carbon emissions in northeast Asia and the rest of the world.

nearly 20%. By 2010, based on projections by Fujime, carbon dioxide emissions from the region will be 23% of the global total, reaching a level nearly double that of 1992. This means that the region will have contributed nearly one-third of the total growth in global carbon emissions between 1980 and 2010. (Fujime 1996) Table 18-6 provides estimates of historical and future greenhouse gas emissions by country for northeast Asia.

Although the process of climate stabilization is one that will of necessity take the better part of a century if not more, an increase like that shown in Figure 18-2 in only the next two decades will make stabilization that much harder to achieve. Managing the growth in fossil fuel use in northeast Asia is therefore one of the keys in reaching greenhouse gas stabilization targets as soon as possible.

Regional impacts of global environmental problems. In addition to some of the environmental impacts of marine pollution related to petroleum transport that are noted in the previous section, northeast Asia is vulnerable to a range of environmental impacts of global climate change. These environmental impacts, in turn, could (and, in many cases, would) spawn a broad range of social and economic impacts in the region.

The environmental impacts of global climate change in the northeast Asia region include, but are not by any means limited to:

Table 18-6. Summary of recent and future CO_2 emissions from fuels use in northeast Asia (carbon dioxide emissions in million tonnes carbon).

Year	China	CT/HK[a]	DPRK[b,c]	Japan	ROK[d]	Total NE Asia	Total Rest of World	Total World
1980	403	27	22	272	37	761	4,491	5,252
1992	697	51	36	326	87	1,197	4,896	6,093
2000	1,011	79	52	334	128	1,604	5,465	7,069
2010	1,515	94	114	339	184	2,246	7,502	9,748
Growth, 1980 - 2010	1,112	67	92	67	147	1,485	3,011	4,496

[a] CT = Chinese Taipei and HK = Hong Kong figures combined.

[b] DPRK = Democratic People's Republic of Korea (North Korea)

[c] 1992 value for DPRK is value calculated for 1990 in Von Hippel, D., and P. Hayes, The Prospects for Energy Efficiency Improvements in the Democratic People's Republic of Korea: Evaluating and Exploring the Options. Nautilus Institute Report, Nautilus Institute for Security and Sustainable Development, Berkeley, CA, USA. 1995. The 1980 value for DPRK emissions was taken to be 60 percent of the 1990 value (based roughly on the difference in coal consumption between the early 1980's and 1990 as reported by the UN). Projections for DPRK carbon emissions were based on increasing the 1990/92 value at 4.5 percent per year, which is somewhat less than the growth rate in energy use implied by the RAINS-Asia base case scenario, but accounts for the fact that the DPRK would probably shift toward less carbon-intensive fuels (if indeed its energy use could grow as projected).

[d] ROK = Republic of Korea (South Korea)

Additional source: Fujime, K., "Long-Term Energy Supply/Demand Outlook for Asia APEC Nations". Energy in Japan, January 1996. The Institute of Energy Economics, Japan (IEEJ), Bimonthly Report No. 137. 1996.

• Changes in average temperature
• Rising sea levels and related impacts
• Changes in precipitation and in the frequency and severity of storms
• Changes in the distribution of ecosystems

A complete discussion of all of the different potential impacts of global climate change in northeast Asia is beyond the scope of this paper. The work of the Intergovernmental Panel on Climate Change (IPCC) and others is available for those interested in obtaining more detailed information (Fujime 1996; IPCC 1996b; Von Hippel 1995).[6]

Change in global temperature. Based on a range of different scenarios of human fossil fuel use and other activities that emit greenhouse gases, the IPCC estimates that global mean temperature will increase by between 1.5°C and 4.5°C, with a "best estimate" of 2.5°C, by 2100, relative to pre-industrial (late 19th century) temperatures. These temperature changes will not be evenly distributed. Temperature changes in northern latitudes, including the Russian Far East, Mongolia, the Koreas, Japan, and northern China, are projected to be higher than changes in the tropics; temperature changes at inland locations are expected to be greater than near the ocean; and the warming of the climate will be greatest in the late autumn and the winter. The recent inclusion of the effects of atmospheric aerosols (small particles, for example, of soot or of sulfate compounds) into the modeling of future climate has changed the projected picture somewhat, particularly in northeast Asia. Aerosol emissions in northeast Asia, particularly in China, have the effect (in computer simulations for the period to 2040–2049) of reducing the temperature increases caused by higher $C0_2$ concentrations. Though aerosols would appear to exert a cooling effect, the magnitude of their impact on climate is still quite uncertain (Kattenberg et al 1996).

Sea level rise. One of the most-noted potential impacts of climate change is sea level rise (SLR). The increase in global temperatures affects the level of the oceans in two different ways. First, when surface ocean waters are heated, they expand and occupy more volume of ocean basin, thus causing sea levels to rise. A second mechanism that causes ocean waters to rise occurs when elevated temperatures cause the ice in polar and mountain glaciers and ice sheets (principally the Antarctic and Greenland ice caps) to melt, and the meltwater from these bodies of ice eventually or directly adds to the amount of water in the ocean. Due to temporal lags in the ocean/ice cap/atmosphere system (Haq 1994), it has been estimated that this second mechanism will provide a relatively minor contribution to overall sea level rise, particularly in the early years of the next century. The behavior of some of the world's major ice sheets—and their response times to climate changes—is quite uncertain.[7] The IPCC's mid-range projections of future sea level rise are for an increase of 20 centimeters by 2050 and 49 cm by 2100 (Warrick et al 1996). Here again, the range of uncertainty is substantial.

The most obvious regional (as well as global) impact of sea level rise (SLR) brought on by climate change is inundation of coastal lands by the higher water level of the oceans. Hundreds of meters to many kilometers of shoreline inundation may result from tens of centimeters of SLR. In China, much of the most productive land is located in the coastal plains, often with an altitude on the order of a few meters above sea level. One estimate suggests that a one-meter rise in sea level would, in the plains of the

Lower Liao and Pearl Rivers, and the north and east China coasts, inundate 92,000 square kilometers, affecting 65 cities and a population of 67 million people (World Bank 1994). Coastal wetlands are especially at risk from increases in the sea level associated with climate change. Studies of several areas in the Asia and Pacific region estimated wetland losses of 35 to over 90% (Nicholls 1994). The changes in climatic variability discussed below—changes in the severity, frequency, and location of storms, for example—will compound the impact of sea level rise, and place coastal ecosystems, infrastructure, and populations even more at risk.

<u>Change in the amount and timing of precipitation, and of the frequency and severity of storms</u>. In a future where the climate has changed, some areas of the Asia and Pacific region may receive more rain than at present, and some less. Note that the various climate models do not necessarily agree on the pattern that these changes will take. For a doubling of atmospheric CO_2 concentrations, model predictions for the East Asian Seas region show slight increases in precipitation (zero to 20%) in both summer and winter (Kattenberg et al 1996), but there is likely to be a large variation of changes in different areas. Estimates for China show an increase in both summer (9.3%) and winter (12.7%) precipitation, but with attending small decreases in both cloud cover and soil moisture (World Bank 1994).

Along with changes in the amount of precipitation, and perhaps more importantly, changes in the timing of precipitation are expected. These changes include the shifting of storm patterns and changes in the severity of storms. Changes in the severity of storms and floods—and erosion exacerbated by storms and floods—as well as in the timing and amount of water discharged by rivers could (as pointed out by the impact of the recent floods in North Korea) have a devastating effect on both ecosystems and on the dense human populations of coastal and river areas. For island areas of the region (particularly in the south), this effect may include an increase in the frequency of hurricanes and typhoons to areas that already experience them, and a widening or shift in the belts of such storms to adversely affect additional island and mainland areas. Rising seas will exacerbate the damage caused by these weather phenomena.

<u>Changes in the distribution of ecosystems</u>. The climate-related changes discussed above can change plant growth conditions, and thus the distribution of ecosystems, in several ways, including:

• Changes in plant growth rates. These changes may include increases in plant growth promoted by higher concentrations of CO_2 in the air. In addition, the northerly portions and countries of the region (such as Japan), may experience greater plant growth as higher average temperatures bring growing seasons. In some areas. decreases in growth rates may result from intolerance of high temperatures by the indigenous plant species or from changes in the amount or timing of precipitation (Topping, Qureshi, and Sherer 1990).

• Changes in forests due to changes in temperature, precipitation, and evaporation. Northeast Asia (particularly the Russian Far East) is home to large tracts of forests, and these forests are important both ecologically and economically. Forest ecosystems are sensitive to climate changes, but due to the long lives and long maturation periods required for large trees in forests, they will probably be less able than other ecosystems to adapt to changes in climate (Qureshi 1993a).

• Changes in the distribution and prevalence of plant and animal pests and diseases, and the changes in the susceptibility of plants and animals to these maladies due to their exposure to changes in temperature and precipitation, and other climate change-induced stress.

• Changes in ocean temperatures and their effects on ocean productivity .

• Changes in biodiversity and species distribution. All of the changes noted above have the potential to alter the distribution and range of plant and animal species, including both domesticated crops and livestock and native flora and fauna. Although the natural inclination of managed and natural ecosystems under climate stresses is to migrate to more favorable areas, these migrations could be frustrated by an inability to migrate—due to physical isolation or limitations posed by other natural or by human communities—or by a rate of climate change that exceeds the ability of those ecosystems to migrate (Qureshi 1993b).

<u>Potential interaction of regional and global environmental problems</u>. Some of the existing (and probable) local and regional environmental problems now experienced in the northeast Asia region may be increased in magnitude—made more difficult to cope with—by the impacts of global climate change. Some of the interactions between global climate change and local/regional impacts could include:

• Climate change-induced stress on ecosystems (through changes in temperature, precipitation, storm patterns, or sea levels) may pose an additional challenge to ecosystems affected by acid precipitation, such as forests and lake communities. Ecosystems stressed by local air pollutants (particulate matter, sulfur oxides, or lead, for example), erosion, or deforestation are also more vulnerable to climate change, as are the human populations that depend on them.[8]

• Sea level rise brought on by climate change will add to salinization (salt intrusion into fresh surface waters and groundwater) in areas—such as around several coastal cities in China—where groundwater pumping and other human activities have caused the land to subside. In areas where subsidence is already a problem, climate change will increase the rate at which land is inundated.

• River, lake, and estuary ecosystems stressed by additions of silt, municipal wastes, and industrial effluents will be more vulnerable to the impacts of climate change. These ecosystems—including fish and other products important for humans—will also be less able to adapt to a changing climate than if they were healthy.

<u>Interaction of climate change and marine pollution impacts with existing human problems in the region</u>. There is a list of potential social and economic impacts of climate change much too long to describe in any detail here.[9] Some of the impacts that are most likely to exacerbate existing human problems in northeast Asia are described briefly below.

• Pressure on agricultural resources and accelerated desertification caused by climate change may accelerate cross-border migration, particularly from China into Russia (a process already under way).

• Climate change impacts may further undermine the ability of North Korea to feed its population, possibly resulting in increased military pressure on South Korea, or rendering the process of reunification more economically burdensome.

• Higher temperatures would likely lead to increased use of air conditioning, which would, in turn, lead to higher fuel consumption for electricity generation, and higher emissions of local and regional air pollutants (as well as greenhouse gases).

• Salinization of estuaries that are the breeding grounds for fish and shellfish caught in shared regional waters (including the East Korea Sea/Sea of Japan) will affect yields of ocean products for all countries, possibly exacerbating conflicts over maritime resources.

• Additional oil pollution of the oceans of the region (as a result of greatly expanded oil imports by the region) could strain relations between countries sharing shipping lanes and marine resources.

• Climate change impacts may increase the human and economic costs of natural disasters (such as catastrophic storms) in the region, and spread even thinner the emergency resources available for responding to such disasters.

Innovative energy financing and the trade-environment interface. Meeting the capital requirements of environmentally sound and secure energy expansion in northeast Asia is the foundation for a strategy aimed at realizing energy and environmental security.[10] The role of private trade, capital, and investment flows will be critical in facilitating the transfer of environmentally sound, affordable energy technologies to China and the two Koreas. Indeed, regional energy development will have major impacts on the global availability of capital for this sector. Meeting the increased demand for fuels in northeast Asia will require huge capital investments in a number of different sectors. including:

• Electricity generation, particularly to meet high growth in demand in China

• Coal mine expansion, and especially, coal transport facilities in China

• Oil exploration and production facilities, including offshore platforms

• Oil tanker docking facilities, again especially in China

• Oil refining—including both new refineries and equipment to allow existing refineries to use high-sulfur (sour) crude oil from the Middle East

• Natural gas pipelines—virtually all of the proposals for bringing gas to northeast Asia involve costs of $10–20 billion or more, even before accounting for the costs of local distribution networks (Valencia and Dorian 1996)

• Liquefied natural gas (LNG) terminals (at up to $1 billion each) and transport vessels (at on the order of $250 million each)

These potential investments will compete among themselves for scarce foreign and domestic capital. They may also compete for capital with environmental investments such as pollution-control equipment, coal mine safety investments, and energy efficiency investments. The potential constraints on the capital markets that can supply the region have not been quantitatively examined in a thorough fashion as yet, but availability of capital remains a consideration that will determine, in part, the evolution of energy infrastructure in the region.

Electricity generation in Asian states that are members of the Asia-Pacific Economic Cooperation (APEC) program is projected to increase from its 1991 level of 235 GWe to 1,100 GWe in 2010—an annual 8% increase. This projected increase will require some $297 billion over the 1991–2000 period; and an additional $557 billion from 2000–2010. About 62% is projected to be in China. It is highly improbable that China can sustain this rate of capital investment in electric power plants, which amounts to an average of $26 billion/year. Moreover, the investment required to control China's sulfur emissions with best available technology would amount to $34 billion per year, according to the RAINS–ASIA model. (However, to the extent that the model used myopic governmental estimates for energy demand projections in the model, it may have overstated the amount of acid rain precursor emissions that have to be controlled: also, the model used primarily international control costs, not the lower costs that would ensue in a scenario wherein China commits to control on a large scale, including domestic manufacture of the control equipment—which would drive cost down by approximately another 25%.)

The critical missing link in this political economic equation is how much it would cost to achieve "best available technology" sulfur reduction in China using energy efficiency rather than emission control technology. If acid rain in China can be reduced by energy efficiency, cleaner coal and control technologies, and a combination of fuel switching (natural gas supplemented by renewables), a substantial fraction of the annual costs referred to above could be avoided. The potential gains may persuade China to accept substantial "green" and efficiency investment by Japan and other donor states. On the other hand, the threat of China's acid rain may induce Japan and South Korea to lead in innovative financing of China's energy sector in ways that provide more energy in China at lesser cost.

At this stage, however, no one has compiled the basic elements of the overall regional picture that would allow a strong argument to be put forward to this end. Similarly, until these elements are assembled, no one can evaluate properly the claim of nuclear power to be the only technological and economic solution to acid rain in the region. What is evident already is that China's constrained governmental budget dictates that the costs and effectiveness levels of control technologies be reduced and adapted to Chinese conditions. At the regional level, common regional energy and energy-related pollution principles and ceiling standards could also help lift the tide for everyone toward a sustainable energy future.

Japanese energy security: de-emphasizing nuclear power?

In this section, we will compare and contrast Japanese and American paradigms of energy security and examine the technological and security implications of the different concepts of energy security that underlie policy, especially with regard to nuclear power and plutonium energy strategies. We will also survey the situation on the Korean Peninsula and the activities of the Korean Peninsula Energy Development Organization as an example of new, cooperative approaches to achieving nuclear nonproliferation via multilateral diplomacy in northeast Asia.

Concepts of energy security in northeast Asia

The long-standing elite consensus in Japan that nuclear power—and, in particular, plutonium—is a critical element in a secure and sustainable energy supply for its economy is now unraveling. The breeder reactor accident in early 1996, the recent local antinuclear referendum vote and the loud regional debate concerning Japan's plutonium and latent nuclear weapons proliferation potential have led to an unraveling of this consensus. The Japanese political culture requires that the consensus be reconstituted before a new public face is put on its nuclear program, and before the plutonium and/or strategies based on light water reactors (LWR) can be abandoned or de-emphasized. This process will take some years.

In the past, specialists from the United States have played a crucial "sounding" board role in facilitating the changes in Japanese energy and security policy at times of change. Ironically, Japan's energy paradigm, including the nuclear power policy, originated in the United States in the 1950s-1970s period. At the same time, Japan represents an economic and technological model for other Asian countries such as South Korea and served as a transmission belt for this worldview to these other states.

Underlying the commitment to Japan's nuclear program is an energy paradigm built around the notion of energy security. This latter notion has deep roots in Japan's 20th-century experience. Historians argue about whether Japan attacked Pearl Harbor because of the U.S.-led oil supply cutoff to Japan in 1939, but most Japanese accept this link to their disastrous involvement in World War II. The OPEC 1973 and 1979 crises also had profound impacts on Japanese concerns about loss of supply of fossil fuel imports. Recent concerns about global warming have provided further impetus to an environmental argument in favor of nuclear power, to reduce greenhouse gas emissions.

Today, however, the concept of energy security is vague and hazy in Japan. The concept is used in Japan to justify investment in stockpiling, and in nonfossil fuel cycles such as nuclear power. In particular, the plutonium-fueled breeder reactor offered a vision, via a uranium-fueled LWR bridge, to a self-reliant energy supply for Japan's economy.

Bureaucratic factors have also come into play. Japan's nuclear energy establishment has been able to pursue what would appear to be an overly ambitious, costly energy security strategy in part because the well-known vertical fragmentation of Japan's public administration has promoted inertia and inhibited the evolution of a comprehensive energy security policy. Japan's energy planning framework is heavily dominated by the bureaucracy, and is vertically fragmented with poor coordination. In spite of the work done by other government, academic, business, and nongovernmental sectors on alternative energy strategies, Japan's energy policy does not give due regard to full economic, environmental, and security costs of various energy mixes.

Operational concepts of energy security

It must be admitted that there are few models of what to look for in an economically and environmentally sound operational concept of "energy security" of the kind that should underlie U.S. and Japanese policy. Three literatures are relevant here. First, and most widespread, is the qualitative focus on political factors affecting energy supply.[11] The second is contractor literature for studies of oil versus nuclear power impacts on import vulnerability, which are still relevant to Japan. The third, the most powerful analytically, is the methodology developed at the World Bank to analyze the economics of investing in “insurance” against fuel supply cutoff in mountainous, landlocked, and isolated, small island states.[12]

All three need to be combined—the first analyzing the long-run stability of oil supply markets and interdependence between suppliers and consumers; the second approach that focuses on the relative supplier market diversity of fuel types; and the third economic methodology that looks at the risk-benefit dimensions of various “insurance” strategies to create an operational concept for energy security in any state, but especially in Japan. It would be very revealing to conduct an analysis comparing the Republic of Korea (ROK), Republic of China (ROC), and Japanese strategies on this score, using the same method. Four important working hypotheses arise from this broad approach to energy security:

Hypothesis 1: A close analytical look at “energy security” will demonstrate that nuclear power increases rather than reduces overall energy import dependence and vulnerability to cutoff; and that over the relevant time horizons, the risk (defined strictly as the probability of fossil fuel cutoff *times* the cost of such cutoffs) is smaller than the assured costs of investing in stockpiling oil, coal, uranium etc., technological (nuclear power/breeder) diversification; and that the fastest, safest, cheapest way to reduce the risk still further is to (a) reduce demand for imports by investing in energy efficiency at home; (b) export energy intensive industries to fossil fuel suppliers, thereby creating interdependence and economic disincentives to cutoff Japan’s fossil fuel imports; and (c) invest in home-grown renewables and geothermal energy in Japan—something that the Japanese are already pursuing at home and in their bilateral aid (especially with China), but with a low priority.

Hypothesis 2: In Asia, as in Europe (reflected in the Energy Charter), subregional integration will create economic incentives to build a subregional energy infrastructure in northeast Asia, which will in itself increase energy supply security. This approach would emphasize “regional energy security.”

Hypothesis 3: Investing in energy security via this alternative path will generate the technological innovation in Japan itself that will make it cheap—and therefore feasible—to create an environmentally sustainable energy development path for China; and that without this element, acid rain from China will reach unacceptable levels in Japan within 20–30 years. Thus, the concept of energy security must now incorporate environmental externalities—a new twist.

Hypothesis 4: Deregulation of the Japanese power industry is hastening a shift away from the plutonium future. Taken together with the Monju, Tokai, and siting problems afflicting the nuclear power industry, deregulation thus predisposes Japanese energy decision makers to be open-minded to new paradigms for the concept of “energy security.” This process will force utilities to make decisions more on the basis of expected returns rather than according to administrative guidance and/or in response to government subsidies. It will also likely expand the circle of decision makers over time (initially to financial and insurance business circles in addition to utility executives, and later to stockholders and the general public as informed by the media). Thus, the time is propitious for such an exercise.

It is timely to reexamine the existing paradigm because: (a) other OECD countries have given up or cut back on nuclear power and plutonium; (b) international reaction to Japan’s plutonium program remains severe: (c) alternate sources and strategies for energy are decreasing rapidly in cost; (d) the energy sector is undergoing deregulation, which in itself calls for a fundamental reconsideration of energy strategy; and (e), the general atmosphere of public mistrust and scandal, the Monju incident, and the recent referendum against siting nuclear power plants.

In short, the time is opportune for a thorough reconsideration of Japan's energy security strategy. In that reformulation, nuclear power should be considered on an equal footing with other sources of energy, in economic, environmental, and security terms.

Criteria for U.S. policy initiatives for environmental security in northeast Asia

The United States and Japan have crucial, unique, and complementary intellectual, institutional, technological, and economic resources to apply to regional energy cooperation. These capabilities arise out of their respective security, economic, and technological positions. Together, these two great powers can jump-start the process of environmental cooperation within the northeast Asian region, whereas left to their own devices, Japan may hesitate, and the United States may neglect these crucial regional issues. This process is an important component of a regional comprehensive security strategy. It will build confidence between the states in the region in ways that will assist in resolving major geopolitical security dilemmas via cooperative engagement.

In this section, we will present a set of criteria for selecting from candidates for a U.S. and Japanese joint policy initiative to respond to the energy dilemmas in northeast Asia, and we will present a set of concrete policy options for consideration by decision makers in search of "environmental security" in this region. In particular. we will analyze the interrelationship between nuclear nonproliferation objectives in this region, and the geopolitical confidence-building potential of energy-environmental cooperation in northeast Asia.

Policy criteria: In general, we suggest that a successful candidate for a U.S. policy initiative on the issues analyzed in this paper will meet *all* of the following criteria:

1. The initiative should generate constituency and political will in the United States, Japan, China, and North and South Korea, including the creation of a common image of the environment and security issues. This may require the development of an epistemic view (for example, by a collaborative remote sensing network) to help characterize problems and resolve scientific uncertainties.

2. The initiative should draw on complementary strengths (analytic, capacity building, technology) of the United States, Japan, and other states in the region, and match these capabilities very carefully with needs.

3. The initiative should build, not destroy, confidence. It should cultivate the perception of common identity and should support:
   - Mutual interest (e.g. migratory birds between Japan and North Korea)

- Self interest (which does not always build mutual interest or confidence)
- Contribution of all parties (no handouts)
- Overlapping security and environmental concerns (geopolitical importance)
- Environmental interdependence (all nations share the atmosphere)
- Shared identity (long-term impact—potential to cause xenophobia)

4. The initiative should use existing institutional channels to implement initiatives. These might include:
   - UNDP/Economic and Social Commission for Asia and the Pacific (ESCAP)-NEAREP (issues—donors not funding it; technology ministries versus foreign ministries; United States and Canada are not members)
   - Asian Institute of Technology–Program for Asia Cooperation on Energy and Environment
   - APEC working groups (issues—multilevel process; diffuse; no concrete agenda)
   - Asian Development Bank(ADB) (issues—Democratic People's Republic of Korea (DPRK) is not a member; biggest funder of NEAREP; chief economist is interested)
   - United Nations Environment Program (UNEP)–Northwest Pacific Action Plan (NOWPAP) (resources to do something on cooperative ocean management; integrated coastal zone management already signed off on; agenda is momentous in scope; DPRK attended every meeting, but the process is now stalled)
   - Korean Peninsula Energy Development Organization (KEDO) (only multilateral institutional framework for engaging DPRK; although it is now partly confidence-destroying due the DPRK's continuing threat to go nuclear [extortion destroys trust]; parties are learning about each other but not trusting each other as a result of KEDO's negotiations, but it has an open-ended agenda and can, should the United States, South Korea, and Japan so decide, include issues beyond nuclear energy and heavy fuel oil)
   - Parallel nongovernmental track with DPRK (U.S. and Japanese foundations went to the DPRK to negotiate areas for cooperation including agriculture/biotechnology, medical technology, energy and environment, cultural
   - Concerted bilateralism by United States and Japan (carve out an area at margins in countries where Japan and United States have relations)
   - Tumen River Area Development Project (TRADP) (UN spawned activity; big vision, no reality; have MOU on environmental principles—already signed; progressive)
   - Northeast Asia Economic Forum (run by East-West Center; will take up energy-environmental issues in 1997
   - Northeast Asia Cooperation Dialogue (NEACD)/Susan Shirk at IGCC (Track II funded by DOE; senior officials discuss political/security issues; DPRK mostly not involved

5. The costs of the initiative, especially at the beginning, should be both small and shared.

Overall, expected outcomes should focus on building confidence and the habit of dialogue in the region; creating institutional and intermediate-level management capacity to deal with problems we are defining; and generating specific and tangible environmental benefits over a definable-time horizon.

With these criteria in mind. we suggest the following candidates for a joint U.S.–Japanese initiative to promote environmental security in the northeast Asian region (these are not exclusive):

- An Acid Rain Monitoring Network, which could include the existing Japanese monitoring network, RAINS–Asia passive monitoring system, and remote sensing or popular monitoring (schools, public etc.) system
- Local government capacity building initiatives, which could include staff development in areas of, for example, air pollution, energy efficiency, green buildings, public health, and environmental regulations
- Nongovernmental organization (NGO)–public education campaign, focusing perhaps on acid rain
- Initiatives to make long range energy planning transparent, an important confidence-building measure that would be the basis for any effective collaboration
- An Energy Efficiency And Clean Coal Fund, including technology demonstrations
- An Air Pollution Regulatory Policy and Implementation Network
- A Nuclear Fuel Cycle Cooperation project, which would comprehensively cover aspects of nuclear material management, including spent fuel, waste storage, disposal and security systems

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Endnotes

1. From multiple sources: U.S. Department of Energy, Energy Information Administration (US DOE EIA). 1996. *International Energy Outlook. 1996.* Washington. D.C.: U.S. DOE; Korea Energy Economics Institute (KEEI). *Energy Scenarios to 2030.* Seoul: KEEI; Fujime, K. 1996. Long-Term Energy Supply/Demand Outlook for Asia APEC Nations. *Energy in Japan.* Bimonthly report No. 137. The Institute of Energy Economics, Japan (IEEJ); Fesharaki. F., A.L. Clark, and D. Intarapravich, editors. 1995. *Pacific Energy Outlook: Strategies and Policy Imperatives to 2010.* East-West Center Program on Resources: Energy and Minerals. Honolulu: East-West Center; RAINS-Asia Software: Working Group on Energy Strategies and Technologies of The China Council for International Cooperation on Environment and Development (CCICED). 1996. *Alternative Energy Strategy Scenarios for China*. Prepared by the Institute for Techno-Economics and Energy Systems Analysis (ITEESA). Beijing: Tsinghua University, Beijing, and China Integrated Resource Planning Promotion Network (IRPPN) International Energy Initiative (IEI); The World Bank. 1994. China: *Issues and Options in Greenhouse Gas Control. Summary Report*. Washington. D.C.: The World Bank Industry and Energy Division.

2. The RAINS-ASIA study coordinated by the World Bank supplemented by Japanese, Korean, and Chinese national studies are the best current sources on acid rain. See G. Carmichael and R. Arndt, Long Range Transport and Deposition of Sulfur in Asia. *RAINS-ASIA: An Assessment Model for Acid Rain in Asia.*. Also see the IIASA web site, which has an excellent description of RAINS-ASIA (http://www.iiasa.ac.at/~heyes/docs/rains.asia.html) INTERNET.

3. A blowout occurs when the well-head where the flow of oil from a well is controlled fails catastrophically, allowing oil, driven by high gas and/or liquid pressures in the well, to flow out of the well and into the surrounding environment.

4. Phytoplankton is a name used to denote the class of microscopic-to-barely-visible aquatic plants that are the base of much of the ocean's food chain. Phytoplankton include marine algae, diatoms, and other photosynthetic organisms. Zooplankton are the micrometer-to-millimeter-size animals that, like the phytoplankton they feed on, float along near the surface of the ocean. Zooplankton include the larval and juvenile (young) stages of a number of commercially and biologically important organisms, such as crustaceans (e.g. shrimp and crab) and mollusks (shellfish). Zooplankton in turn serve as food for small fish and other animals.

5. Most of the tanker traffic headed for the region will need to pass through the straits that lie between Malaysia/Singapore and Indonesia. Traffic headed for Southern and Eastern China, the Koreas, and Japan usually passes through the Formosa or Luzon Straits, the East China Sea, and often the Korea Strait to service tanker terminals on the east coasts of South Korea and Japan.

6. For example: Chapters 6 through 10 in Intergovernmental Panel on Climate Change (IPCC),*Climate Change 1995: The Science of Climate Change*;*Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change*;, *Scientific-Technical Analyses, Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change*; Chapters 1 through 12 in *Climate Change 1995: Impacts, Adaptations, and Mitigation of Climate Change: Scientific-Technical Analyses*;*Contribution of Working Group II to the Second Assessment Report of the Intergovernmental Panel on Climate Change*; and Chapters 6 to 10 in *Climate Change 1995: Economic and Social Dimensions of Climate Change., Contribution of Working Group III to the Second Assessment Report of the Intergovernmental Panel on Climate Change. A*ll three volumes were published for the IPCC by Cambridge University Press, New York, in 1996.

7. For example, elevated temperatures could cause the West Antarctic ice sheets to slide into the sea at an increasing rate, which would produce a quicker contribution to sea level than if the sheets simply melted *in situ*. There may be a significant lag in the melting or movement of ice sheets as a result of elevated global temperatures. In other words, sea level rise could continue long after temperature changes have stopped.

8. A particular example here is the recent flooding in North Korea. In this case, the lack of forest cover (due to a combination of the impacts of war and inadequate soil conservation) undoubtedly played a role in exacerbating the impacts of severe storms. Though the storms of 1995 and 1996 may not (or may) have been altered by climate change, their devastating impacts serve as a warning for what could happen in the region when the effects of a changing climate impinge upon areas already under ecological stress.

9. For more information on this topic, the reader is encouraged to see *Climate Change 1995: Economic and Social Dimensions of Climate Change. Contribution of Working Group III to the Second Assessment Report of the Intergovernmental Panel on Climate Change*. New York: Cambridge University Press. 1996.

10. See: Resource Dynamics Corporation. *Financing Worldwide Electric Power: Can Capital Markets Do the Job?* U.S. DOE report, contract DE-ACOI-92FE62489; H. Razavi 1996. *Financing Energy Projects in Emerging Economies*. Tulsa: Pennwell Books; APEC Energy Working Group. *Action Program for Energy* (http://www.dpie.gov.au/resources.energy/energy/apec/action1.html) INTERNET.

11. For an old version of this approach, see Nye, Joseph. 1996. Japan. D. Deese and J. Nye, ed. 1981. *Energy and Security.* Cambridge, Mass.:Ballinger. A recent application is found in Kent Calder's *Pacific Defense, Arms, Energy, and America's Future in Asia*, New York: Morrow, 1996.

12. See, for example, the Joint UNDP/World Bank Energy Sector Assessment Programme, *Issues and Options in the Energy Sector,* reports for Burundi (No. 3778-BU, June 1982) and for Fiji (No. 4462-FIJ, June 1983).